

WHAT IS CLAIMED IS:

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1. An optical transmission system comprising  
a transmitting-end optical transmission device, a  
receiving-end optical transmission device and an  
optical transmission line connecting the  
10 transmitting-end and receiving-end optical  
transmission devices,

the transmitting-end optical transmission  
device comprising:

encoding means having  $n$  outputs, for forming  
15  $k$  data by aligning phases of data on  $k$  channels with  
each other and for generating  $(n-k)$  error correction  
bits for said  $k$  data and adding said  $(n-k)$  error  
correction bits to said  $k$  data; and

wavelength-multiplexing means connected to  
20 the encoding means, for converting both said  $k$  data  
and said  $(n-k)$  error correction bits to  $n$  optical  
signals having different wavelengths and for  
wavelength-multiplexing said  $n$  optical signals so as  
to be delivered to the optical transmission line, and

25 the receiving-end optical transmission  
device comprising:

wavelength-demultiplexing means for  
separating the wavelength-multiplexed optical signals  
from the optical transmission line into  $n$  optical  
30 signals, each corresponding to one of the different  
wavelengths; and

decoding means connected to the  
wavelength-multiplexing means, for generating  $k$  error  
corrected data by correcting error bits using the  $(n-k)$   
35 error correction bits contained in said  $n$  separated  
optical signals.

2. An optical transmission system comprising

5 a transmitting-end optical transmission device, a receiving-end optical transmission device and an optical transmission line connecting the transmitting-end and receiving-end optical transmission devices,

10 the transmitting-end optical transmission device comprising:

parity generating means for forming k data by adding an SOH (Section Over Head) including at least one error monitoring byte to data on k channels and

15 aligning phases of said data with each other and for generating a parity bit for said k data and adding said parity bit to said k data; and

wavelength-multiplexing means connected to the parity generating means, for converting said k data and said parity bit to (k+1) optical signals having

20 different wavelengths and for wavelength-multiplexing said (k+1) optical signals so as to be delivered to the optical transmission line, and

the receiving-end optical transmission

25 device comprising:

wavelength-demultiplexing means for separating the wavelength-multiplexed optical signals from the optical transmission line into (k+1) optical signals, each corresponding to one of the different

30 wavelengths; and

error correction means connected to the wavelength-multiplexing means, for correcting error bits based on one result of a parity check for said separated (k+1) optical signals and the other result

35 of a parity check using said at least one error monitoring byte.

3. An optical transmission system comprising  
5 a transmitting-end optical transmission device, a  
receiving-end optical transmission device and an  
optical transmission line connecting the  
transmitting-end and receiving-end optical  
transmission devices,  
10 the transmitting-end optical transmission  
device comprising:  
encoding means having  $k$  input and  $n$  outputs,  
for generating  $(n-k)$  error correction bits for every  
transmission data having  $k$  bits; and  
15 wavelength-multiplexing means connected to  
the encoding means, for converting said transmission  
data and said  $(n-k)$  error correction bits to  $n$  optical  
signals having different wavelengths and for  
wavelength-multiplexing said  $n$  optical signals so as  
20 to be delivered to the optical transmission line, and  
the receiving-end optical transmission  
device comprising:  
wavelength-demultiplexing means for  
separating the wavelength-multiplexed optical signals  
25 from the optical transmission line into  $n$  optical  
signals, each corresponding to one of the different  
wavelengths; and  
decoding means connected to the  
wavelength-multiplexing means, for correcting error  
30 bits of data having  $k$  bits contained in said  $n$  separated  
optical signals by using said  $(n-k)$  error correction  
bits contained in said  $n$  separated optical signals.

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4. An optical transmission system comprising

a transmitting-end optical transmission device, a receiving-end optical transmission device and an optical transmission line connecting the transmitting-end and receiving-end optical transmission devices,

the transmitting-end optical transmission device comprising:

encoding means having  $k$  input and  $n$  output, for generating  $(n-k)$  error correction bits for transmission data on  $k$  channels and adding the  $(n-k)$  error correction bits to the transmission data so as to form a sequence of  $n$  data;

multiplexing and frame generating means connected to the encoding means, for adding a frame synchronization information to each data in the sequence of the  $n$  data and time-division-multiplexing the  $n$  data; and

electrical-optical converting means connected to the multiplexing and frame generating means, for converting the time-division-multiplexed  $n$  data into  $n$  optical signals so as to deliver the  $n$  optical signals to the optical transmission line, and

the receiving-end optical transmission device comprising:

optical-electrical converting means for converting the  $n$  optical signals via the optical transmission line to electrical signals;

separating means connected to the optical-electrical converting means, for separating the electrical signals into a sequence of  $n$  data by detecting the frame synchronization information; and

decoding means connected to the separating means, for performing error correction decoding for a sequence of  $k$  data from said separated sequence of the  $n$  data using a sequence of  $(n-k)$  data from said separated sequence of the  $n$  data.

5. An optical transmission device  
5 comprising:  
encoding means having  $k$  inputs, for forming  
 $n$  data by generating  $(n-k)$  error correction bits for  
 $k$  data corresponding to  $k$  channels and adding the  $(n-k)$   
error correction bits to the  $k$  data;  
10 phase alignment means for aligning phases of  
the  $n$  data received from the encoding means;  
electrical-optical converting means for  
converting the  $n$  data aligned in phase by the phase  
alignment means to  $n$  optical signals having different  
15 wavelengths; and  
wavelength-multiplexing means for  
multiplexing the  $n$  optical signals having the  
different wavelengths received from the  
electrical-optical converting means so as to form  
20 wavelength-multiplexed signals.

25 6. An optical transmission device  
comprising:  
wavelength-demultiplexing means for  
separating wavelength-multiplexed optical signals  
having  $n$  wavelengths into  $n$  optical signals  
30 corresponding to the  $n$  wavelengths;  
optical-electrical converting means  
connected to the wavelength-demultiplexing means, for  
receiving and converting the separated  $n$  optical  
signals corresponding to the  $n$  wavelengths into  $n$   
35 electrical signals; and  
decoding means for performing an error  
correction decoding for  $k$  data contained in the  $n$

electrical signals converted by the optical-electrical converting means using  $(n-k)$  error correction bits contained in said  $n$  electrical signals.

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7. An optical transmission device  
10 comprising:  
frame generating and SOH inserting means for adding an SOH (Section Over Head) to data for each of  $k$  channels such that all the  $k$  data can be aligned in phase by means of a frame synchronization byte within  
15 each SOH;  
encoding means having  $n$  outputs and connected to the frame generating and SOH inserting means, for receiving the  $k$  data with the SOH, generating  $(n-k)$  error correction bits for the  $k$  data  
20 without taking the frame synchronization bytes into account, adding a frame synchronization byte to each of the  $(n-k)$  error correction bits and forming  $n$  data, each of the  $n$  data including its frame synchronization byte, by combining the  $(n-k)$  error correction bits and  
25 the  $k$  data corresponding to the  $k$  channels;  
electrical-optical means for converting the  $n$  data from the encoding means into  $n$  optical signals having different wavelengths; and  
wavelength-multiplexing means connected to  
30 the electrical-optical converting means, for multiplexing the  $n$  optical signals from the electrical-optical converting means so as to form wavelength-multiplexed signals.

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8. An optical transmission device comprising:

5 wavelength-demultiplexing means for separating wavelength-multiplexed optical signals having  $n$  wavelengths into  $n$  optical signals corresponding to the  $n$  wavelengths;

10 optical-electrical converting means connected to the wavelength-demultiplexing means, for receiving and converting the separated  $n$  optical signals corresponding to the  $n$  wavelengths into  $n$  electrical signals;

frame top detecting means for detecting a top of a frame for each of the  $n$  electrical signals converted by the optical-electrical converting means;

15 memory means for storing the  $n$  electrical signals converted by the optical-electrical converting means and outputting the stored  $n$  electrical signals such that the tops of the frames detected by the frame top detecting means are aligned with each other;

20 decoding means for performing an error correction decoding for  $k$  data contained in the  $n$  electrical signals converted by the optical-electrical converting means using  $(n-k)$  error correction bits contained in said  $n$  electrical signals; and

30 SOH (Section Over Head) terminating means for receiving the  $k$  data from the decoding means and terminating an SOH for said every  $k$  data.

9. An optical transmission device comprising:

SOH inserting means for adding an SOH (Section Over Head) including an error monitoring byte

to data for each of  $k$  channels;

parity generating means for receiving the data for each of the  $k$  channels from the SOH inserting means, calculating and adding a parity to the data so  
5 as to generate  $(k+1)$  data;

phase alignment means for aligning phases of the  $(k+1)$  data received from the parity generating means;

electrical-optical converting means for  
10 converting the  $(k+1)$  data whose phases are aligned by the phase alignment means to  $(k+1)$  optical signals having different phases; and

wavelength-multiplexing means for  
multiplexing the  $(k+1)$  optical signals from the  
15 electrical-optical converting means so as to form wavelength-multiplexed signals.

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10. An optical transmission device comprising:

wavelength-demultiplexing means for separating  $(k+1)$  multiplexed optical signals into  
25  $(k+1)$  optical signals having  $(k+1)$  wavelengths, respectively;

optical-electrical converting means for receiving the separated  $(k+1)$  optical signals from the wavelength-demultiplexing means and converting said  
30  $(k+1)$  optical signals into  $(k+1)$  electrical signals;

parity detection means for receiving the  $(k+1)$  electrical signals received from the optical-electrical converting means and locating a bit position of an error bit by checking a parity contained  
35 in said received  $(k+1)$  electrical signals and by performing parity check for each data of the  $k$  electrical signals corresponding to  $k$  channels using



at least one error monitoring byte attached to said  
k electrical signals; and

error correction means for performing an  
error correction at the bit position of the error bit  
5 located by the parity detection means.

10 11. An optical transmission device  
comprising:

encoding means having k inputs and n outputs,  
for generating (n-k) error correction bits for every  
k bits of transmission data;

15 phase alignment means for aligning both tops  
of the transmission data having the k bits and the (n-k)  
error correction bits in phase;

electrical-optical converting means for  
converting the transmission data and the error  
20 correction bits aligned in phase with one another by  
the phase alignment means to optical signals having  
different wavelengths;

wavelength-multiplexing means for receiving  
from the electrical-optical means and multiplexing the  
25 optical signals having the different wavelengths.

30 12. An optical transmission device  
comprising:

wavelength-demultiplexing means for  
separating wavelength-multiplexed optical signals  
into n optical signals having different wavelengths;

35 optical-electrical converting means for  
converting the n optical signals having the different  
wavelengths to n electrical signals including k bits

representing transmission data;

decoding means receiving the  $n$  electrical signals from the optical-electrical converting means, for performing error correction decoding for every  
5 said  $k$  bits using  $(n-k)$  bits representing error correction bits.

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13. An optical transmission device comprising:

encoding means having  $k$  input and  $n$  output, for generating  $(n-k)$  error correction bits for  
15 transmission data on  $k$  channels and adding the  $(n-k)$  error correction bits to the transmission data so as to form a sequence of  $n$  data;

multiplexing and frame generating means connected to the encoding means, for adding a frame  
20 synchronization information to each data in the sequence of the  $n$  data and time-division-multiplexing the  $n$  data; and

electrical-optical converting means connected to the multiplexing and frame generating  
25 means, for converting the time-division-multiplexed  $n$  data into  $n$  optical signals so as to deliver the  $n$  optical signals to an optical transmission line.

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14. An optical transmission device comprising:

optical-electrical converting means for  
35 converting time-division-multiplexed signals to electrical signals;

separating means connected to the

optical-electrical converting means, for separating the electrical signals into a sequence of  $n$  data including  $k$  bits representing transmission data and  $(n-k)$  bits representing error correction bits by  
5 detecting a frame synchronization information; and decoding means connected to the separating means, for performing error correction decoding for every said  $k$  bits using said  $(n-k)$  error correction bits.

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15 15. An optical transmission device having  $n$  channels comprising:

encoding means for generating error correction bits for  $m$  data corresponding to any  $m$  channels of  $k$  channels representing transmission data,  $k$  being less than  $n$  and a number of the error correction  
20 bits being  $(n-k)$ ;

identification signal inserting means connected to the encoding means, for inserting an identification signal into each of the  $m$  data and the  $(n-k)$  error correction bits from the encoding means;

25 multiplexing means connected to the identification signal inserting means, for time-division-multiplexing  $(k-m)$  data rather than said  $m$  data in the transmission data, and, said  $m$  data as well as said  $(n-k)$  error correction bits; and

30 electrical-optical converting means for receiving from the multiplexing means and converting the time-division-multiplexed signals to optical signals.

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16. An optical transmission device having  $n$  channels comprising:

optical-electrical converting means for converting time-division-multiplexed signals

5 including  $k$  data representing transmission data for  $k$  channels in the  $n$  channels and  $(n-k)$  error correction bits to  $n$  electrical signals;

separating means for separating the  $n$  electrical signals receiving from the optical-  
10 electrical converting means into a sequence of  $n$  data;

identification signal detecting means for detecting  $m$  data and the  $(n-k)$  error correction bits in the sequence of the  $n$  data received from the separating means, each of the  $m$  data and the  $(n-k)$  error  
15 correction bits having an identification signal; and

decoding means receiving the  $k$  data and the  $(n-k)$  error correction bits from the identification signal detecting means, for performing error correction decoding on the  $m$  data using the  $(n-k)$  error  
20 correction bits.

25 17. An optical transmission device having  $n$  channels comprising:

encoding means receiving  $m$  data corresponding to any  $m$  channels of  $k$  channels representing transmission data and  $(k-m)$  fixed data,  
30 for generating  $(n-k)$  error correction,  $k$  being less than  $n$ ;

identification signal inserting means connected to the encoding means, for inserting an identification signal into each of the  $m$  data and the  
35  $(n-k)$  error correction bits;

multiplexing means connected to the identification signal inserting means, for time-

division-multiplexing (k-m) data rather than said m data in the transmission data, and, said m data as well as said (n-k) error correction bits; and

5       electrical-optical converting means for receiving from the multiplexing means and converting the time-division-multiplexed signals to optical signals.

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18. An optical transmission device having n channels comprising:

15       optical-electrical converting means for converting time-division-multiplexed signals including k data representing transmission data for k channels in the n channels and (n-k) error correction bits to n electrical signals;

20       separating means for separating the n electrical signals receiving from the optical-electrical converting means into a sequence of n data;

      identification signal detecting means for detecting m data and the (n-k) error correction bits in the sequence of the n data received from the separating means, each of the m data and the (n-k) error correction bits having an identification signal; and

25       decoding means receiving the m data as well as the (n-k) error correction bits from the identification signal detecting means and (k-m) fixed data, for performing error correction decoding on the m data using the (n-k) error correction bits.

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19. An optical transmission device comprising:

frame generating and SOH inserting means for adding an SOH (Section Over Head) to data for each of k channels such that all the k data can be aligned in phase by means of a frame synchronization byte within each SOH;

5 encoding means having n outputs and connected to the frame generating and SOH inserting means, for receiving the k data with the SOH, generating (n-k) error correction bits for the k data without taking the frame synchronization bytes into account, adding a frame synchronization byte to each of the (n-k) error correction bits and forming n data, each of the n data including its frame synchronization byte, by combining the (n-k) error correction bits and the k data corresponding to the k channels; and

15 electrical-optical converting means for converting the n data from the encoding means into n optical signals having different wavelengths.

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20. An optical transmission device comprising:

25 optical-electrical converting means for converting n optical signals corresponding to n wavelengths into n electrical signals;

frame top detecting means for detecting a top of a frame for each of the n electrical signals converted by the optical-electrical converting means;

30 memory means for storing the n electrical signals converted by the optical-electrical converting means and outputting the stored n electrical signals such that the tops of the frames detected by the frame top detecting means are aligned with each other;

35 decoding means for performing an error

correction decoding for  $k$  data contained in the  $n$  electrical signals converted by the optical-electrical converting means using  $(n-k)$  error correction bits contained in said  $n$  electrical

5 signals; and

SOH (Section Over Head) terminating means for receiving the  $k$  data from the decoding means and terminating an SOH for said every  $k$  data.

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